

CHAPTER 27

Nutrition And Digestion

Nutrition

- includes all those processes by which an animal take in, digests, absorbs, stores, and uses food (nutrients) to meet its metabolic needs.

Digestion

- is the chemical and/or mechanical breakdown of food into particles that individual cells of an animal can absorb.

EVOLUTION OF NUTRITION

- Autotrophs - self nourishing
- Heterotrophs – consuming other organism or their products.
 - herbivores
 - carnivores
 - omnivores
 - insectivores

THE METABOLIC FATES OF NUTRIENTS IN HETEROTROPHS

Macronutrients

- are needed in large quantities and include the carbohydrates, lipids, and proteins.

Micronutrients

- are needed in small quantities and include organic vitamins and inorganic minerals.

Calories and energy

- Calorie - is the amount of energy required to raise the temperature of 1 g of water 1
- gram calorie
- Kilocalorie – is equal to 1,000 calories.

MACRONUTRIENTS

Heterotrophs require organic molecules, such as carbohydrates, lipids, and proteins, in their diet. Enzymes breakdown these molecules into components that can be used for energy production or as source for the “building blocks” of life.

CARBOHYDRATES: CARBON AND ENERGY FROM SUGARS AND STARCHES

- Carbohydrates – also are major carbon source for incorporation into important organic compounds.
- Cellulose – a polysaccharide that humans and other animals cannot digest.
 - dietary fiber
 - it assists in the passage of food through the alimentary canal of mammals.
 - reduce the risk of cancer of the colon because the mutagenic compounds that form during the storage of feces are reduced if fecal elimination is more frequent.

Lipids: Highly Compact Energy Storage Nutrients

- Neutral lipids (fats) or triacylglycerol are in fat and oil, meat and some fruits and vegetables high in fats, such as avocados.
- Lipids are most concentrated source of food energy.
- The sterols are also required for synthesis of steroid hormones and cholesterol, which is incorporated into cell membranes.
- Lipids insulate the bodies of some vertebrates and help maintain a constant temperature.

Proteins: Basic to the Structure and Function of Cells

- Proteins are needed for their amino acids, which heterotrophs use to build their own body proteins.

MICRONUTRIENTS

- usually small ions, organic, vitamins, inorganic minerals, and molecules that are used repeatedly in enzymatic reactions or as parts of certain proteins (e.g., copper in hemocyanin and iron in hemoglobin).

Minerals

- are needed relatively large amounts and are called essential minerals, or macrominerals.
- are also known as trace minerals, trace elements, or microminerals.

VITAMINS

- is the general term for a number of chemical unrelated, organic substances that occur in foods in small amounts and are necessary for normal metabolic functioning.

Most water soluble vitamins, such as the B vitamins and C vitamins

The fat soluble vitamins (A, D,E and K)

Digestion

Intracellular digestion – cells take in whole food particles directly from the environment by diffusion, active transport, and/or endocytosis and break them down with enzymes to obtain nutrients.

Extracellular digestion – the enzymatic break down of larger pieces of food into constituent molecules, usually in a special organ or cavity.

Animals strategies for getting and using food

Continuous versus Discontinuous Feeders

Continuous feeders

- are slow moving or completely sessile (they remain in one place).

Discontinuous feeders

- tend to be active, sometimes highly mobile animals.

- have more digestion specializations than continuous feeders because discontinuous feeders take in large meals that must be either ground up or stored, or both.

Suspension feeders

- is the removal of suspended food particles from the surrounding water by some sort of capture, trapping or filtration structure.

This feeding strategy involves three steps:

1. Transport of water past the feeding structure
2. Removal of nutrients from the water
3. Transport of the nutrients to the mouth of the digestive system.

Deposit Feeders

- these animals obtain nutrients from the sediments of soft bottom habitats of terrestrial soils.

Herbivory

- feeding strategy requires the ability to “bite and chew” large pieces of plant matter (macroherbivory).

Biting and chewing mechanisms evolved within the architectural framework of a number of invertebrate lineages, they often characterized by the development of hard surfaces (e.g., teeth) that powerful muscles manipulate.

- molluscs
- polychaetes
- arthropods

Predation

- is one of the most sophisticated feeding strategies, since it requires the capture of live prey.

Predators can be classified by how they capture their prey:

- Motile Stalkers actively pursue their prey.
- Lurking predators sits and wait for their prey to come within the seizing distance.
- Sessile opportunists they can only capture their prey when the prey organism comes into contact with them.
- Grazing carnivores move about the picking up small organism. Their diet usually consist largely of sessile and slow moving animals.

Surface Nutrient Absorption

- they directly absorb nutrients from the external medium across their body surfaces. This medium may be nutrient rich seawater, fluid in other animals' digestive tracts or the body fluid of other animals.
- The endoparasitic protozoa, cestode worms, endoparasitic gastropods, and crustaceans (all of which lack mouth and digestive system) also absorb all of the nutrients across their surface body.
- A few nonparasitic multicellular animals also lack of mouth and digestive system and absorb nutrients across their body surface.

Fluid feeders

- feed on the fluid.

- Intestinal nematodes that bite and rasp off host tissue or suck blood.
- External parasites (ectoparasites) use a wide variety of mouthparts to feed on body fluid.
- Insects have the most highly developed sucking structures for fluid feeding.
- Most pollen and nectar feeding birds have long bills and tongues.
- Other nectar feeding birds have short bills.
- The only mammals that feed exclusively on blood are the vampire bats such as *Desmodus*.
- Nectar feeding bats have long tongue to extract the nectar from flowering plants.

DIVERSITY IN DIGESTIVE STRUCTURES: INVERTEBRATES

Gastrovascular cavity – the gut is blind (closed) sac

Incomplete digestive tract – it has only one opening that is both entrance and exit.

- Some specialized cells in the cavity secrete digestive enzyme that begin the process of extracellular digestion.
- Other phagocytic cells that line the cavity engulf food material and continue intracellular digestion inside food vacuoles.

Complete digestive tract – permits the one way flow of ingested food without mixing it with the previously ingested food or waste.

Digestive system in protozoa and invertebrates:

1. The incomplete digestive system of ciliated protozoan is an example of an intracellular digestive system.
2. The bivalve mollusc is an example of an invertebrate that has both intracellular and extracellular digestion.
3. An insect is an example of an invertebrate that has extracellular digestion and a complete digestive tract.

Protozoa

- may be autotrophic, saprozoic, or heterotrophic (ingest food particles)

- ciliated protozoa are good examples of protists that utilize heterotrophic nutrition

- * Ciliary action directs food from the environment into the buccal cavity and cytostome. The cytostome opens into the cytopharynx, which enlarges as food enters and pinches off a food containing